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(71) Applicant: SEIKO EPSON CORPORATION
Shinjuku-ku, Tokyo 163-0811 (JP)

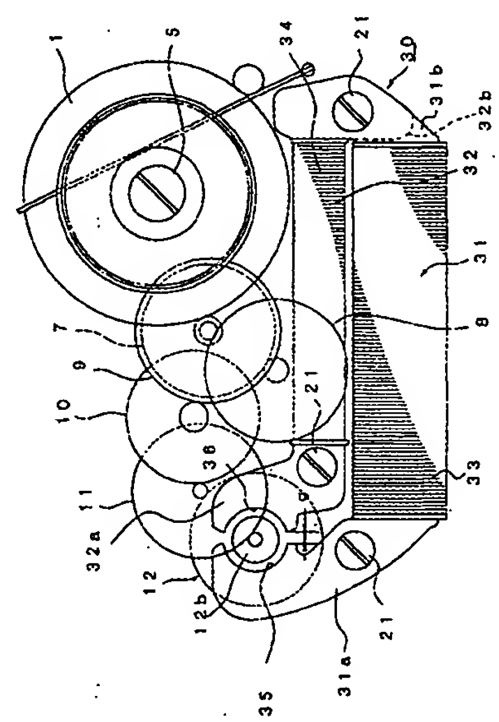
(72) Inventors:
- Takahashi, Osamu
Suwa-shi, Nagano-ken 392-8502 (JP)
- Hara, Tatsuo
Suwa-shi, Nagano-ken 392-8502 (JP)
- Moteki, Masatoshi
Suwa-shi, Nagano-ken 392-8502 (JP)
- Nagasaka, Eiichi
Suwa-shi, Nagano-ken 392-8502 (JP)

(74) Representative: Sturt, Clifford Mark et al
Miller Sturt Kenyon
9 John Street
London WC1N 2ES (GB)

(54) **Electronically controlled mechanical timepiece**

(57) The invention provides an electronically controlled mechanical timepiece which can be handled easily and by which yields can be improved, a generated voltage can be increased and the number of rotations can be simply detected. A generator 30 of an electronically controlled mechanical timepiece comprises a rotor 12 rotating in association with the rotation of a wheel train, two plate-shaped stators 31, 32, a pair of semicircular stator holes 35, 36 formed to respective ends of both the stators 31, 32 and disposed around the rotor 12 in the form of a circle in a state that both the stators 31, 32 are combined and coils 33, 34 wound around the periphery of at least one of the stators 31, 32. Since the stator holes 35, 36 are composed of the two stators 31, 32, external notches which are required by an integrally arranged stator need not be formed.

[FIG. 1]



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Description

[0001] The present invention relates to an electronically controlled mechanical timepiece which is operated using mechanical energy generated when a mainspring is released as a drive source as well as converting a part of the mechanical energy into electric energy and controls a rotation cycle by actuating rotation controlling means by the electric energy, and more specifically, to the improvement of a generator which converts mechanical energy into electric energy and uses it as control power.

[0002] A principle for driving an electronically controlled mechanical timepiece is such that a generator connected to a train wheel is used in place of a mechanical speed control mechanism composed of a timed annular balance and an escape wheel which are inherent to the mechanical timepiece, although the train wheel is driven using a mainspring as an energy source. The generator generates power by receiving rotation from the train wheel, a control electronic circuit is driven by the power generated by the generator and the rotation cycle of the generator is controlled in response to a control signal from the electronic circuit to thereby control the speed of the train wheel by applying a brake thereto. Therefore, a battery acting as a drive source of the electronic circuit is not necessary in this structure and further a pinpoint accuracy similar to that of an battery-driven electronic clock can be obtained.

[0003] There is a technology which was previously developed by the applicant and shown in Japanese Unexamined Patent Publication No. 8-5758 as prior art of this type of a hybrid type timepiece. FIG. 16 is a plan view of a timepiece disclosed in the publication and FIG. 17 is an exploded perspective view of a generator used in the timepiece.

[0004] The electronically controlled mechanical timepiece includes a movement barrel 1 composed of a mainspring, a barrel gear, a barrel arbor and a barrel lid. The mainspring has an external end fixed to the barrel gear and an internal end fixed to the barrel arbor. The barrel arbor is supported by a main plate and a train wheel bridge and fixed by a ratchet wheel screw 5 so that it is rotated integrally with a ratchet wheel 4. The ratchet wheel 4 is meshed with a detent 6 so that it is rotated clockwise and is not rotated counterclockwise.

[0005] The speed of the rotational power from the movement barrel 1 containing the mainspring is increased through the train wheel composed of a second wheel 7, a third wheel 8, a fourth wheel 9, a fifth wheel 10 and a sixth wheel 11 and supplied to the generator 20.

[0006] The generator 20 has a structure similar to a step motor for driving a conventional battery-drive-type electronic clock and is composed of a rotor 12, a stator 15 and a coil block 16.

[0007] The rotor 12 is composed of a rotor magnet 12b and a rotor inertia disc 12c attached around a rotor pinion 12a integrally therewith which is rotated by being connected to the sixth wheel 11.

[0008] A stator coil 15a is wound around the periphery of the stator 15. The stator 15 has a stator hole 15b opened to the extreme end thereof for rotatably accommodating the rotor magnet 12b, a pair of external notches 15c formed at intervals of 180° around the periphery of the stator hole 15b and recessed toward the stator hole 15b. The rear end of the stator 15 is fixed to a not shown main plate by a screw 21.

[0009] The coil block 16 is composed of a magnetic core 16a and a coil 16b wound around the magnetic core 16a and both the ends of the coil block 16 overlap both the ends of the stator 15 and are tightened together by a pair of screws 21 and fixed to the main plate so as to be integrated therewith.

[0010] The stator 15 and the magnetic core 16a are made of a PC Permalloy material and the stator coil 15a is connected in series to the coil 16b to provide an output voltage obtained by adding the voltages generated by them.

[0011] The generator 20 supplies the power obtained by the rotation of the rotor 12 to an electronic circuit having a crystal oscillator through a not shown capacitor. The electronic circuit detects the number of rotations of the rotor and supplies a rotor rotation control signal to the coils in accordance with a reference frequency. As a result, the train wheel is rotated at a constant rotational speed at all times in accordance with a braking force applied thereto.

[0012] However, the generator 20 having the above structure has a problem in the structure and a problem in electromagnetic characteristics.

[0013] The generator 20 follows the structure of the conventional step motor as well as being additionally provided with the coil block 16 in order to advantageously generate power while avoiding crowding the other parts such as the train wheel and the like, that is, in order to increase the number of turns of the coil as much as possible.

[0014] As a result, the stator hole 15b is formed to have a cantilever support structure as shown in the figure and an electromagnetic problem is caused by the generator, although the problem is not caused in the step motor.

[0015] First, since the stator hole 15b is formed integrally with the stator 15 by stamping or the like, a flux passes through the external notches 15c. As a pole of the rotor magnet 12b of the rotor 12 passes through the external notches 15c, the fluxes of the coils almost do not change although the fluxes of the external notches 15c change, whereby the generated voltage drops.

[0016] As a countermeasure for preventing the above problem, the width of the external notches 15c is sufficiently reduced in a manufacturing process to thereby decrease the amount of the voltage drop.

[0017] When this countermeasure is employed, however, the stator hole 15b is liable to be deformed even

by a slight amount of external force applied thereto while it is processed or in a next process such as winding, annealing and the like. Accordingly, permeance is varied by the change of the diameter of the stator hole 15b or the deformation thereof and cogging torque is increased, by which efficiency as a generator is lowered.

[0018] A most simple method of detecting the number of rotations of a rotor is to detect the waveform of generated power and convert it into a binary value. However, since the generated voltage is actually dropped at the notch passing-through positions as described above, the waveform is a complex mountain-shaped waveform as shown in FIG. 18(b) and it is difficult to detect the waveform.

[0019] Further, a finished product is finally attached to the main plate by screws in combination with the coil block 16. However, since the coils are heavy, the portion of the stator 15 located on the extreme end side from the external notches 15c is liable to be bent or deformed easily even if a very slight force is applied thereto and careful caution is required in the handling thereof.

[0020] It is needless to say that a product to which the deformation is caused is disposed of as a defective product in an inspection process, the reduction of yields cannot be avoided.

[0021] An object of the present invention is to provide an electronically controlled mechanical timepiece which can solve the problem in handling and improve yields as well as increase a generated voltage at the same time by dividing a stator hole into two sections and easily detect the number of rotations by making the waveform of the generated power a sine wave.

[0022] An electronically controlled mechanical timepiece of the present invention for driving a train wheel using a mainspring as an energy source as well as causing a generator, which is rotated by receiving rotation from the train wheel, to generate power and applying a brake to the train wheel and regulating the speed thereof by controlling the rotation cycle of the generator by an electronic circuit driven by the power is characterized by the generator comprising a rotor rotating in association with the rotation of the train wheel, two plate-shaped stators, a pair of semi-circular stator holes formed to respective ends of both the stators and disposed around the rotor in the form of a circle in a state that both the stators are combined, and a coil wound around the periphery of at least one of the stators.

[0023] Since the stator holes are divided into the two sections, there can be prevented difficulty in handling and a drop in a yield which are caused by the provision of external notches which are a defect of a conventional single stator hole device. In addition, since the generated voltage is increased and the waveform of the voltage is made in to a sine wave, rotation can be easily detected.

[0024] It is advantageous to the generator to wind coils around the peripheries of both the stators and connect the coils in series to each other because a generated voltage can be increased by increasing the number of turns by the above arrangement.

[0025] The coil wound around the periphery of the stator may generate electromotive force as well as control rotation. In this case, the number of wirings connected to the coil can be reduced.

[0026] At least two coils may be wound around the peripheries of the stators, at least one of the coils may used to control rotation and at least one of the other coils may be used to generate electromotive force to be supplied to the electronic circuit.

[0027] When the plurality of coils are provided, since the functions of the respective coils are perfectly separately set to the function for controlling the rotation and the function for generating the electromotive force, the generated voltage is not reduced by the application of an electromagnetic brake, the voltage is stabilized and the disturbance of the waveform of the voltage can be suppressed.

[0028] It is preferable that at least one of the coils used to generate the electromotive force also detects the rotation of the rotor. In this case, since the disturbance of the waveform of the voltage of the coil can be eliminated, the rotation cycle of the rotor can be easily detected.

[0029] It is preferable to provide a positioning member capable of being abutted against the edges of the stators on the stator hole sides thereof and positioning jigs for pressing the stators against the positioning member and abutting them thereagainst. When a pair of stator holes are formed by two stators, a gap between the two stators and a rotor magnet must very preferably be uniformly set. When the gap is dispersed, cogging torque is increased and the number of fluxes flowing in a coil is changed by a rotor which is strongly pulled to one of the stators. Accordingly, the amount of power generated and the torque for rotating a generator are not stabilized. When the stators are positioned while measuring the gap between the stators and the rotor, workability is lowered in assembly. Whereas, the provision of the positioning jigs as mentioned above permits the stators to be correctly and easily positioned in a state that the rotor is interposed between the stators.

[0030] It is preferable that the positioning jigs have inclined surfaces obliquely pressed against the edges of the stators so that the stators are positioned in a height direction by the inclined surfaces. In this case, the positioning jigs permit not only the task of positioning the stators in a diameter direction but also the task of positioning them in a sectional direction to be easily carried out.

[0031] The stators may be symmetrically disposed with respect to the right side and the left side. In this case, the right and left parts (stators) can be commonly used, whereby a cost can be reduced.

[0032] It is preferable that the same number of turns of coils are wound around both the stators.

[0033] With this arrangement, since the same number

of fluxes due to AC noise and the like generated externally of the clock can flow between the two coils, the affect of the external noise can be eliminated and a detecting performance can be improved.

[0034] It is preferable that an internal notch projecting toward the outside is formed at at least one of confronting positions of the inner peripheries of the stator holes to regulate cogging torque. The formation of the internal notch can smooth the rotation of the rotor by lowering cogging torque when the magnetic pole of the rotor passes through the position of the notch.

[0035] It is preferable that the sides of the other ends of the stators which are opposite to the one ends thereof where the stator holes are formed are abutted against each other as well as the lower surfaces of the other ends are abutted against a yoke disposed across the stators.

[0036] With this arrangement, there can be formed two magnetic conducting paths, that is, a path passing through the portion where the sides of the stators are in contact with each other and a path ranging from the lower surface of one of the stators to the lower surface of the other of them through the yoke. Although a flux is liable to flow in the side direction of the stators, when the magnetic conducting path is formed only by the portion where the sides of the stators are in contact with each other, a magnetic resistance is dispersed by the dispersion of a gap between the sides. Accordingly, the additional magnetic conducting path formed by disposing the yoke on the lower surfaces of the stators can stabilize the magnetic resistance.

[0037] Further, it is preferable that the wheels constituting the train wheel are disposed on a different axial line so that they are disposed at positions where they do not overlap the coil. When the respective wheels constituting the train wheel are disposed on a different axial line, a degree of freedom of the disposition of the wheels can be increased in design. As a result, when the wheels are disposed so as to be roundabout toward the rotor, the wheels can be disposed at positions where they do not overlap the coils. Accordingly, since the number of turns can be increased by increasing the diameter of the coils, the length of the coils in an axial direction, that is, the length of a magnetic path can be reduced, whereby the duration of the mainspring can be increased by reducing iron loss.

[0038] Embodiments of the present invention will be described by way of further example only and with reference to the accompanying drawings, in which: -

FIG. 1 is a plan view of an electronically controlled mechanical timepiece of a first embodiment of the present invention.
FIG. 2 is a sectional view of a main portion of FIG. 1.
FIG. 3 is an exploded perspective view of a generator.
FIG. 4 is a circuit block diagram showing how the generator of the first embodiment is connected to an electronic circuit.
FIG. 5 is a circuit diagram showing a short-circuit circuit of FIG. 4.
FIG. 6 is a plan view showing a second embodiment of the present invention.
FIG. 7 is a sectional view taken along the line V - V of FIG. 6.
FIG. 8 is a plan view showing a third embodiment of the present invention.
FIG. 9 is a sectional view taken along the line VII - VII of FIG. 8.
FIG. 10 is a sectional view taken along the line VIII - VIII of FIG. 8.
FIG. 11 is a plan view showing a main portion of an electronically controlled mechanical timepiece of a fourth embodiment of the present invention.
FIG. 12 is a sectional view showing a main portion of the fourth embodiment.
FIG. 13 is a sectional view showing a main portion of the fourth embodiment.
FIG. 14 is a circuit block diagram showing how the generator of the fifth embodiment is connected to an electronic circuit.
FIG. 15 is a circuit block diagram showing how the generator of the sixth embodiment is connected to an electronic circuit.
FIG. 16 is a plan view of an electronically controlled mechanical timepiece provided with a conventional generator.
FIG. 17 is an exploded perspective view of the generator of Fig. 16.
FIG. 18(a) is a graph showing a voltage waveform of the generator according to the present invention and 18(b) is a graph showing a voltage waveform of the conventional generator, and
FIG. 19 is a circuit block diagram of another embodiment of the present invention.

FIG. 1 to FIG. 3 show a first embodiment of the present invention. In the respective figures, since an electronically controlled mechanical timepiece is arranged similarly to the conventional electronically controlled mechanical timepiece except that a main portion of the arrangement of a generator is different from that of the generator of the conventional timepiece, the same or corresponding parts are denoted by the same numerals and only different parts or parts to be newly described are denoted by different numerals.

[0039] In the figures, the clock of the present invention is arranged such that the rotational power from a movement barrel 1 is supplied to a generator 30 according to the present invention after its speed is increased through a train wheel.

[0040] More specifically, the rotation of a gear of the movement barrel 1 is transmitted to a second wheel 7 after its speed is increased to 7 times the initial speed thereof and further successively transmitted to a third

wheel 8 after its speed is increased to 6.4 times, to a fourth wheel 9 after its speed is increased to 9.375 times, to a fifth wheel 10 after its speed is increased to 3 times, to a sixth wheel 11 after its speed is increased to 10 times and finally to the rotor 12 of the generator 30 of the present invention after its speed is increased to 10 times. That is, the rotation of the gear of the movement barrel 1 is increased 126,000 times in total for transmission.

[0041] As shown in FIG. 2, a canon pinion 7a is fixed to the second wheel 7, a minute hand 13 is fixed to the canon pinion 7a and a second hand 14 is fixed to the fourth wheel 9, respectively. Therefore, the rotor 12 must be controlled to rotate at 5 rpm in order to rotate the second wheel 7 at 1 rpm and the fourth wheel 9 at 1 rpm. In FIG. 2, numeral 2 denotes a main plate and numeral 3 denotes a train wheel bridge.

[0042] The rotor 12 of the generator 30 is arranged similarly to a conventional rotor. On the other hand, although a stator is disposed on the main plate 2 like the stator of the a conventional generator, it is composed of a combination of a wide stator 31 corresponding to the magnetic core of the above coil block and a narrow stator 32, as shown in FIG. 1 and FIG. 3 in detail. A coil 33 and a coil 34 are wound around the stator 31 and the stator 32, respectively and the coil 33 is connected in series to the coil 34.

[0043] Semi-circular stator holes 35, 36 are formed in confrontation with each other at the positions where the extreme end 31a of the stator 31 confronts the extreme end 32a of the stator 32 so that a rotor magnet 12b is rotatably accommodate therein. Further, inserting hole 31c, 32c are individually formed to the extreme ends 31a, 32a so that screws 21 for fixing them to the main plate 2 are inserted therethrough.

[0044] The rear ends 31b, 32b of both the stators 31, 32 are formed to such a shape that one of them overlaps the other of them so that the stator 31 is connected to the stator 32 to thereby form a magnetic path. Inserting holes (screw holes) 31c, 32c are defined to the rear ends 31b, 32b at the center of the overlapped portions to tighten them together to the main plate 2 by inserting a common screw 21 therethrough.

[0045] Therefore, when the stators 31, 32 which are arranged as described above are assembled, the stator holes 35, 36 are disposed to surround the periphery of the rotor magnet 12b in a state that they are separated from each other with a gap g defined therebetween at the center of them.

[0046] The coils 33, 34 connected in series to each other are used to generate electromotive force, to detect the rotation of the rotor 12 and to control the rotation of the generator 30. More specifically, an electronic circuit 240 (see fig. 4) composed of an IC is driven by the electromotive force of the coils 33, 34 to thereby detect the rotation of the rotor 12 and control the rotation of the generator 30. The electronic circuit 240 is composed of an oscillating circuit 242 for driving a quartz oscillator 241, a dividing circuit 243 for producing a reference frequency signal serving as a time signal based on a clock signal generated by the oscillating circuit 242, a sensing circuit 244 for detecting the rotation of the rotor 12, a comparison circuit 245 for comparing a rotation cycle obtained by the sensing circuit 244 with the reference frequency signal and outputting a difference therebetween and a control circuit 246 for transmitting a control signal to the generator 30 in accordance with the difference. The clock signal may be generated using various types of a reference standard oscillation source in place of the quartz oscillator 241.

[0047] The respective circuits 242 - 246 are driven by the power generated in the series-connected coils 33, 34. When the rotor 12 of the generator 30 receives the rotation from the train wheel and is rotated in one direction, an AC output is generated in the coils 33, 34, the output is boosted and rectified by a boosting/charging circuit composed of a diode 247 and a capacitor 248 and the control circuit (electronic circuit) 240 is driven by the rectified DC current.

[0048] A part of the AC output from the coils 33, 34 is taken out as a signal for detecting the rotation cycle of the rotor 12 and input to the sensing circuit 244. An output waveform output from the coils 33, 34 draws a correct sine wave each time the rotor 12 rotates once. Therefore, the sensing circuit 244 subjects the signal to A/D conversion and provides a time series pulse signal. The comparison circuit 245 compares the detected signal with the reference frequency signal and the control circuit 246 transmits a control signal to a short-circuit circuit 249 acting as a brake circuit of the coils 33, 34 in accordance with the difference therebetween.

[0049] The short-circuit 249 short-circuits both the ends of the coils 33, 34 based on the control signal from the control circuit 246 and applies a short-circuit brake to the rotor 12 to thereby control the rotation cycle thereof.

[0050] As shown in FIG. 5, the short-circuit circuit 249 is composed of a two-way switch composed of a pair of diodes 251 which causes a current to pass therethrough in an opposite direction, switches SW connected in series to the diodes 251 and parasitic diodes 250 connected in parallel to the switches SW. With this arrangement, brake control can be executed using the full wave of the AC output from the coils 33, 34 so that a braking amount can be increased.

[0051] FIG. 18(a) shows the power generating characteristics of the generator 30 arranged as described above, wherein the dimension, number of turns and the like of the coils of the generator 30 are the same as those of the conventional generator shown in FIG. 16 and FIG. 17. FIG. 18(a) shows a result of measurement executed by connecting the output ends of the coils to an oscilloscope. The following effects can be obtained by the embodiment.

1) Since the two stators 31, 32 are used, a gener-

ated voltage can be increased as compared with a case provided with conventional external notches and an output waveform can be made to a correct sine wave for each cycle as compared with a conventional output waveform (see FIG. 18(b)).

As a result, the generating capability of the generator can be improved and when the same voltage as that of a conventional generator is obtained, the size of the generator can be reduced. Further, since the output waveform is a proper sine wave, the output waveform can be easily detected by making it to a binary value by dividing it by a proper threshold value and the number of rotations and the like of the rotor 12 can be easily detected. Therefore, the clock making use of the output waveform of the generator can be correctly and simply controlled.

2) Since the stators 31, 32 do not have a fragile portion which is made by a cantilevered stator hole and the like and a portion which is liable to be deformed such as external notches in its structure, they can be simply handled in respective processes, by which a drop in yields can be prevented.

3) Since the stators 31, 32 are fixed by the screws 21 in the vicinity of the stator holes 35, 36, the stator holes 35, 36 can be accurately positioned with respect to the rotor 12.

4) Since the rear ends 31b, 32b of the two stators 31, 32 are directly connected to each other by the screw 21, an annular loop through which a flux flows can be formed only by the two stators 31, 32. As a result, the flux can easily flow by reducing the number of contacts as well as an increase of the number of parts can be suppressed.

5) Since the short-circuit circuit 249 connected to the coils 33, 34 is composed of the two-way switch, the braking amount can be increased by making use of the full wave, whereby the brake control can be effectively carried out.

FIG. 6 and FIG. 7 show a second embodiment of the present invention. In the figures, a generator 40 is composed of a pair of C-shaped stators 41 formed to the same shape and coils 42 wound around the peripheries of the stators 41, both the coils having the same number of turns and are connected in series to each other. Semi-circular stator holes 43 are formed in confrontation with each other with gaps G defined therebetween to the confronting ends of the extreme ends 41a of the stators 41.

In addition to the above, internal notches 44 serving as recesses for regulating cogging torque are formed toward the outside in confrontation with each other to both the stator holes 43 at the positions thereof which are at 90° from the positions of the gaps. The extreme ends 41a are individually fixed to a main plate 2 by screws 21.

Both the stators 41 are arranged as a two-sheet-laminating type. That is, the laminating portions of the rear ends 41b of the stators 41 are cut-out and stepped portions 41c are formed thereto so that the rear ends 41b can be made flat when they are laminated. Further, the rear ends 41b are fixed to the main plate 2 by a screw 21 which passes therethrough.

The coils 43 have the same number of turns. However, since the number of turns of a coil is usually a unit of several tens of thousands of turns, the same number of turns includes not only a case that the number of turns is perfectly the same but also a case having an error of turns which is negligible for the coils as a whole such as, for example, several hundreds of turns. Further, the second embodiment is also provided with an electronic circuit and the like similar to those of the first embodiment to detect rotation and to control rotation.

The second embodiment can obtain the following effects in addition to effects similar to the effects 1) - 5) of the first embodiment.

6) Since the stators 41 have the same shape, the same parts can be used by reversing its front side and back side, whereby the parts can be commonly used and the number of parts can be reduced. Thus, a manufacturing cost and part costs can be reduced and the parts can be easily handled.

7) Since the stators 41 having the same shape are symmetrically disposed on the right side and left side and the same number of turns of the coils 42 are wound around the stators 41, the same number of fluxes resulting from AC noise and the like which are caused externally of the clock flow in the two coils 42 and the affect of the external noise can be cancelled by the fluxes. As a result, there can be formed an electronically controlled mechanical timepiece which is resistive to noise.

8) Since the internal notches 44 are formed in the stators 41, the cogging torque of the rotor magnet 12b passing therethrough is reduced, whereby the rotor 12 can be more smoothly rotated. In particular, since the magnetic pole of the rotor magnet 12b is liable to be stopped in the directions 90° from the gaps, the formation of the internal notches 44 at the above positions can effectively reduce the cogging torque by cancelling the torque which makes the rotor magnet 12b liable to stop in the gap direction.

9) Since the stators 41 are arranged as the two-sheet-laminating type and directly connected to each other, a leakage flux is reduced as well and since the stepped portions can be formed to the laminating portions, positioning can be conveniently carried out in assembly.

FIG. 8 - FIG. 10 shown a third embodiment of the present invention. In the figures, a generator 50 is composed of L-shaped stators 51 formed to the same shape and coils 52 wound around the peripheries of the stators 51, both the coils 52 having the same number of turns and being connected in series to each other. Semi-circular stator holes 43 are

formed to the extreme ends 51a of the stators 51 and internal notches 54 are formed to the stator holes 53 at the positions thereof at 90° from the positions of the gaps G, respectively.

Further, a positioning member 60 is formed to the edge of the extreme ends 51a on the stator holes 53 side thereof and disposed on a main plate 2 as shown in FIG. 9A. The positioning member 60 is formed in a ring shape around the stator holes 53.

Positioning jigs 55 are disposed on both the sides of the extreme ends 51a of the stators 51 in place of fixing screws, respectively.

Although the positioning jig 55 is analogous to a screw, it is rotatably supported by the main plate 2 while deflecting its axial center 55a as shown in FIG. 9A and FIG. 9B. In the type of the positioning jig 55 shown in FIG. 9A, when a small flat-screw-shaped head 55b is turned while pressing the upper surface of the extreme end 51a with it, the extreme end 51a can be moved in the diameter direction of the stator holes 53 as shown by an arrow. With this operation, the extreme end 51a of the stator 51 can be correctly and simply aligned by abutting the stator 51 against the positioning member 60.

The positioning jig 55 may be provided with a small coned-disc-screw-shaped head 55c as shown in FIG. 9(b). In this case, when the head 55c is rotated while causing the upper surface corner of the extreme end 51a to be in contact with the inclined surface thereof, not only the extreme end 51a is moved in the diameter direction of the stator hole 53 as shown by an arrow and abutted against the positioning members 60 but also the stator 51 is abutted against the main plate 2 so that it can be aligned vertically.

The positioning jig 55 is composed of a plastic material which is softer than the material of the stator regardless of the arrangement thereof. When, for example, the positioning member is not provided, the positioning jigs 55 may be used for the fine adjustment of the position of the stators 51. After the completion of the positioning, the stators 51 are fixed using the screws or the like of the above embodiment.

As shown in the sectional view of FIG. 10, an end of a circuit substrate 56 which is connected to the lead wires of the coils 52 is disposed on the rear end portions 51b of the stators 51, a circuit pressing plate 57 is disposed on the circuit substrate 56, a yoke 58 is disposed under the rear end portions 51b and the respective rear end portions 51b are fixed to the main plate 2 by screws 21 through the above members.

The third embodiment can obtain the following effects in addition to effects similar to the effects 1) - 3), 6) - 8) of the first and second embodiments.

10) Since the positioning jigs 55 and the positioning member 60 are provided, the stators 51 can be aligned in a state that the rotor 12 is disposed in the stator holes 53. Thus, the position of the stators 51 can be most suitably set to the rotor 12, for example, just before the product is shipped, whereby a positional accuracy can be more enhanced.

11) Since the circuit substrate 56 can be connected to the lead wires of the coils by fixing the end of the circuit substrate 56, the lead wires can be connected to an electronic circuit without soldering them, which is preferable to save space.

12) Since the positioning jigs 55 are composed of a material such as plastic which is softer than the material of the stators 51, the stators 51 can be prevented from being damaged by the positioning jigs 55.

13) The use of the positioning jigs 55 having the coned-disc-screw-shaped head 55c and the inclined surface thereof can reliably press the stators 51 against the main plate 2, whereby rattling of the stators 51 can be more reliably prevented.

Next, a fourth embodiment of the present invention will be described. Parts similar or corresponding to those of the aforesaid embodiments are denoted by the same numerals as in the third embodiment and the description thereof is omitted or simplified.

FIG. 11 is a plan view showing a main portion of an electronically controlled mechanical timepiece according to the third embodiment and FIG. 12 and FIG. 13 are sectional views thereof.

The electronically controlled mechanical timepiece includes a movement barrel 1 composed of a mainspring 1a, a barrel gear 1b, a barrel arbor 1c and a barrel lid 1d. The mainspring 1a has an outer end connected to the barrel gear 1b and an inner end connected to the barrel arbor 1c. The cylindrical barrel arbor 1c is fixed by a ratchet wheel screw 5 inserted into a support member disposed to a main plate 2 and rotated together with the ratchet wheel 4. A calendar plate 2a and a dial 2b are attached to the main plate 2.

The rotation of the barrel gear 1b is increased to 126,000 times the initial rotation thereof through respective wheels 7 - 11 serving as a speed increasing train wheel as in the first embodiment. At the time, the wheels 7 - 11 are disposed on a different axial line so that they do not overlap coils 124, 134 which will be described later. The wheels 7 - 11 form a torque transmission path from the mainspring 1a.

A minute hand (not shown) for displaying time is fixed to a canon pinion 7a which is engaged with the second wheel 7 and a second hand (not shown) for displaying time is fixed to a center second pinion 14a, respectively. Therefore, a rotor 12 must be controlled to rotate at 5 rps in order to rotate the second wheel at 1 rpm and the center second pinion 14a at 1 rpm. At the time, the barrel gear 1b rotates at 1/7 rph.

The backlash of the center second pinion 14a located out of the torque transmission path is restricted by a pointer restricting unit 140 interposed between the movement barrel 1 and the coil 124. The pointer restricting unit 140 is composed of a pair of linear restricting springs 141, 142 subjected to surface processing using Teflon, inter-molecule-coupled film or the like and collets 143, 144 as a fixing members which support the base ends of the restricting springs 141, 142 and are fixed to a center wheel bridge 113.

The electronically controlled mechanical timepiece includes a generator 120 composed of the rotor 12 and coil blocks 121, 131. The rotor 12 is composed of a rotor pinion 12a and a rotor magnet 12b.

The coil blocks 121, 131 are composed of stators (magnetic cores) 123, 133 and coils 124, 134 wound therearound. The stators 123, 133 are composed of core stator portions 122, 132 disposed adjacent to the rotor 12, core winding portions 123b, 133b around which the coils 124, 134 are wound and core magnetic conducting portions 123a, 133a which are connected to each other and these components are formed integrally with each other.

The stators 123, 133, that is, the coils 124, 134 are disposed in parallel with each other. The rotor 12 is disposed on the core stator portions 122, 132 side such that the center axis thereof is located on a boundary line L which passes between the coils 124, 134. The core stator portions 122, 132 are disposed on the right side and the left side so as to be symmetrical with respect to the boundary line L.

A positioning member 60 is disposed to the stator holes 122a, 132a of the stators 123, 133 where the rotor 12 is disposed as shown in FIG. 12. Positioning jigs 55 each composed of a deflected pin are disposed to intermediate positions of the stators 123, 133 in the lengthwise direction thereof, that is, disposed between the core stator portions 122, 132 and the core magnetic conducting portions 123a, 133a. The rotation of the positioning jigs 55 causes the core stator portions 122, 132 of the stators 123, 133 to be abutted against the positioning member 60 so that they can be correctly and simply aligned as well as causes the sides of the core magnetic conducting portions 123a, 133a to reliably come into contact with each other.

The number of turns of the coil 124 is the same as that of the coil 134. The same number of turns includes not only a case that the number of turns is perfectly the same but also a case having an error of turns which is negligible for the coils as a whole such as, for example, several hundreds of turns.

The sides of the core magnetic conducting portions 123a, 133a of the stators 123, 133 are abutted against and connected to each other as shown in FIG. 13. Further, the lower surfaces of the core magnetic conducting portions 123a, 133a are in contact with a yoke 58 disposed across them. With this arrangement, two magnetic conducting paths, that is, a magnetic conducting path passing through the sides of the core magnetic conducting portions 123a, 133a and a magnetic conducting path passing through the lower surfaces of the core magnetic conducting portions 123a, 133a and the yoke 58 are formed and the stators 123, 133 form an annular magnetic circuit. The coils 124, 134 are wound in the same direction from the core magnetic conducting portions 123a, 133a of the stators 123, 133 to the core stator portions 122, 132.

The ends of the coils 124, 134 are connected to a coil lead substrate (not shown) disposed on the core magnetic conducting portions 123a, 133a of the stators 123, 133.

In the use of the electronically controlled mechanical timepiece arranged as described above, when an external magnetic field H (FIG. 11) is applied to the coils 124, 134, since it is applied to the coils 124, 134 disposed in parallel with each other in the same direction, it is oppositely applied to the winding directions of the coils 124, 134. As a result, since the voltages generated by the external magnetic field H in coils 124, 134 cancel each other, the affect of the voltage can be reduced.

The fourth embodiment arranged as described above can obtain the following effects in addition to effects similar to the effects 1) - 3), 6), 7), 10) - 13) of the above respective embodiments.

14) Since the second to sixth wheels 7 - 11 are disposed on a different axial line, respectively, a degree of freedom of design of the wheels 7 - 11 can be increased. Thus, when the wheels 7 - 11 are disposed so as to be roundabout toward the rotor 12 by locating the center second pinion 14a out of the torque transmission path, the wheels 7 - 11 can be disposed at positions where they do not overlap the coils 124, 134. Accordingly, since the number of turns can be increased by increasing the size of the coils 124, 134 in a width direction, the length of the coils 124, 134 in a flat surface direction, that is, the length of a magnetic path can be reduced, whereby the duration of the mainspring 1a can be increased by reducing iron loss.

15) Further, since the rotor 12 is disposed on the boundary line L and the core stator portions 122, 132 are symmetrically disposed on the right side and the left side, the magnetic path of the core stator portions 122, 132 can be shortened as compared with the first embodiment. The magnetic path can be also shortened in this respect so that the iron loss can be reduced.

16) Since the two magnetic conducting paths are formed of the core magnetic conducting portions 123a, 133a, a magnetic resistance can be reduced and stabilized. More specifically, although the fluxes in the core magnetic conducting portions 123a,

133a are liable to flow in a side direction, the portion where the sides of the core magnetic conducting portions 123a, 133a are in contact with each other is liable to be dispersed in its gap depending upon a product and there is a possibility that a magnetic resistance is also dispersed. On the other hand, when the magnetic conducting path is arranged through the yoke 58 similar to the third embodiment, a flux is difficult to flow as compared with the side direction and a magnetic resistance cannot be much reduced, although the dispersion of the gap can be reduced.

Whereas, when the two magnetic conducting paths are formed as shown in the fourth embodiment, the magnetic resistance can be reduced and stabilized. Since the stabilization of the magnetic resistance also stabilizes cogging torque, the cogging torque can be reduced by the provision of internal notches corresponding to the torque. Further, a generated voltage can be stabilized as well as power generation and braking can be also stabilized. Further, a leakage flux can be reduced, whereby eddy loss can be reduced in metal parts.

17) Since the positioning jigs 55 are disposed between the core stator portions 122, 132 and the core magnetic conducting portions 123a, 133a, the core stator portions 122, 132 can be aligned and the abutting state of the core magnetic conducting portions 123a, 133a can be regulated by one of the positioning jigs 55 for each of the stators 123, 133. With this arrangement, the number of the positioning jigs 55 can be reduced, the arrangement thereof can be simplified and the cost thereof can be reduced.

18) Since magnetic noise due to the external magnetic field H can be reduced, it is not necessary to provide movement parts such as the dial 2b of the electronically controlled mechanical timepiece with a magnetic resistant plate and to use a material having an magnetic resistant effect to exterior parts. As a result, cost can be reduced as well as the movement can be reduced in size and thickness because the magnetic resistant plate and the like are not necessary. Accordingly, a degree of freedom of design is increased because the disposition and the like of the respective parts is not limited by the exterior parts, whereby there can be provided an electronically controlled mechanical timepiece excellent in design, manufacturing efficiency and the like.

19) The center second pinion 14a does not need a torque transmission gear and the like which overlap the movement barrel 1 because it is located out of the torque transmitting path. Thus, the thickness of the mainspring 1a can be increased thereby and the duration of the mainspring 1a operation can be more extended while maintaining the thickness of the clock as a whole.

Next, a fifth embodiment of the present invention will be described.

The fifth embodiment is characterized in that coils 33, 34 which are connected in series to each other in the first embodiment are not connected to each other and are used for different purposes. The first coil 33 and the second coil 34 are wound around stators 31, 32 in the fifth embodiment similar to the first embodiment. The first coil 33 is used as a braking coil and the second coil 34 having a larger number of turns is solely used as a coil for generating power and detecting the rotation of the rotor 12.

FIG. 14 shows a circuit arrangement of the fifth embodiment, wherein an electronic circuit 240 which is composed of an IC is composed of an oscillating circuit 242 for driving a quartz oscillator 241, a dividing circuit 243 for producing a reference frequency signal serving as a time signal based on a clock signal generated by the oscillating circuit 242, a sensing circuit 244 for detecting the rotation of the rotor 12, a comparison circuit 245 for comparing the rotation cycle obtained by the sensing circuit 244 with the reference frequency signal and outputting a difference therebetween and a control circuit 246 for transmitting a control signal for controlling a generator 30 in accordance with the difference. The clock signal may be generated using various types of a reference standard oscillation source in place of the quartz oscillator 241.

The circuits 242 - 246 are driven by the power generated in the second coil 34. When the rotor 12 of the generator 30 receives the rotation from the train wheel and is rotated in one direction, an AC output is generated in the second coil 34, the output is boosted and rectified by a boosting/charging circuit composed of a diode 247 and a capacitor 248 and the control circuit (electronic circuit) 240 is driven by the rectified DC current.

A portion of the AC output from the second coil 34 is taken out as a signal for detecting the rotation cycle of the rotor 12 and input to the sensing circuit 244. The waveform output from the second coil 34 draws a correct sine wave for each rotation cycle, similar to FIG. 18(a). Therefore, the sensing circuit 244 subjects the signal to A/D conversion and provides a time series pulse signal. The detected signal is compared with the reference frequency signal by the comparison circuit 245 and the control circuit 246 transmits a control signal to a short-circuit circuit 249 acting as the brake circuit of the first coil 33 in accordance with the difference therebetween.

The short-circuit circuit 249 short-circuits both the ends of the first coil 33 based on the control signal from the control circuit 246 and applies a short-circuit brake to the coil 33 to thereby regulate the rotation cycle of the rotor 12.

The fifth embodiment can obtain the following effects in addition to effects similar to those obtained by the above embodiments.

20) Since the functions of the coils 33, 34 wound around the stators 31, 32 are perfectly separately set, the first coil 33 is used only for brake control and the second coil 34 is used only to generate power and detect rotation, the voltage generated by the second coil is not affected by an electromagnetic brake, whereby the generated voltage can be stabilized and a power generating efficiency can be improved.

21) Since the output from the second coil 34 is not affected by the electromagnetic brake, a sine wave which does not have disturbance in each cycle and which is more correct than that of the above embodiments can be output, an output waveform can be easily detected by converting the sine wave to a binary value by dividing it by a proper threshold value and the number of rotations of the rotor 12 and the like can be easily detected. Therefore, the clock making use of the output waveform of the generator can be correctly and simply controlled.

FIG. 15 shows a sixth embodiment of the present invention. Parts similar to those of the fifth embodiment are denoted by the same numerals and only different parts will be described with reference to different numerals denoting them.

The sixth embodiment is arranged similarly to the fifth embodiment except that it is provided with a rotation sensor 260 for detecting the rotation of the rotor 12 in place of the detection of the waveform of an AC output. The value detected by the rotation sensor 260 is input to a detecting circuit 244. Various types of sensors such an optical sensor may be used as the rotation sensor 260 so long as they can detect the rotation of the rotor 12.

The sixth embodiment uses the output from a coil 34 only as a power source for driving an electronic circuit 240.

The sixth embodiment can obtain the following effect in addition to an effect similar to the effect 20) of the fifth embodiment.

22) Since the second coil 34 is used only for power generation, there is an advantage in that the power generating efficiency can be improved thereby.

However, the fifth embodiment is more advantageous than the sixth embodiment in cost and structure because the sixth embodiment needs the rotation sensor 260 additionally.

The present invention is not limited to the aforesaid embodiments and includes modifications, improvements and the like within the range where they can achieve the object of the present invention.

For example, although the coils 42, 52 and 124, 134 of the two stators 41, 51 and 123, 133 are wound in the same number of turns in the embodiments 2 - 4, they may be wound in a different number of turns. However, the same number of turns is preferable because the external noise can be cancelled thereby.

When the two stators 31, 32 have a different shape as shown in the first embodiment, the affect of the external noise may be cancelled by properly setting the number of turns of the coils 33, 34 in accordance with the shape of the stators 31, 32.

When the coils 33, 34 are not connected in series to each other and the functions thereof are separately set as shown in the fifth and sixth embodiments, the number of turns of the coils 33, 34 may be set in accordance with their functions.

Although the coils are wound around the two stators 31, 32, 41, 51, and 123, 133, respectively in the above embodiments, the coil may be wound around each one of the stators 31, 32, 41, 51, and 123, 133. The number of turns and the like of the coil may be suitably set in accordance with a power generating capability and the like needed by the electronically controlled mechanical timepiece.

When the internal notch is formed to the stator hole, the two internal notches in total are formed to the confronting positions of the stator hole in the second and third embodiments. However, only one internal notch may be formed to the stator hole. When only one internal notch is formed, the affect of dispersion of the notch caused in a manufacturing process can be reduced because the notch can be formed in a large size. Whereas, when the two internal notches are formed as shown in the above embodiments, the stator can be formed to a symmetrical shape and arranged as the same part. Therefore, the number of different parts can be reduced and a manufacturing cost can be reduced thereby. Although the positions of the internal notches are not limited to the positions 90° from the gap positions, it is preferable to locate them at the above positions because the positions can most effectively reduce cogging torque. In addition, the shape and the like of the stators may be suitably set when they are manufactured.

FIG. 19 shows another embodiment of the present invention. Since this embodiment is also similar to the first embodiment shown as shown in FIG. 4 except the main portion thereof, the same components are denoted by the same numerals and the description thereof is omitted and only different components are described using different numerals.

In the embodiment, a second coil 34 is connected only to a sensing circuit 44 and used only to detect the rotation of a rotor. Thus, an electronic circuit 40 is driven by a battery 70. A battery which need not be replaced such as a solar battery, a piezoelectric device, a thermo-power generating device or the like may be used as the battery 70, although an ordinary button type battery which must be replaced may be used.

The embodiment can obtain the effect that since the second coil 34 is solely used to detect the

rotation of the rotor 12 and need not generate power for driving the electronic circuit 40, the number of turns of the coil is reduced and a generator 30 can be decreased in size, in addition to effects similar to various other effects of the first embodiment.

As generally described above, according to the electronically controlled mechanical timepiece of the present invention, the two stators are combined and the stator hole is divided into the two portions. Accordingly, there can be prevented difficulty in handling and a drop in a yield which are caused by the provision of external notches which are a defect of a conventional integrally formed stator hole. In addition, an increase in a generated voltage is advantageous for the drive of the electronic control circuit. Further, since the waveform of the voltage is a sine wave, rotation can be easily detected and the control system can be easily arranged.

Claims

1. An electronically controlled mechanical timepiece for driving a train wheel using a mainspring as an energy source as well as causing a generator, which is rotated by receiving rotation from the train wheel, to generate power and applying a brake to the train wheel and regulating the speed thereof by controlling the rotation cycle of the generator by an electronic circuit driven by the power, wherein the generator is characterized by comprising:

   a rotor rotating in association with the rotation of the train wheel;
   two plate-shaped stators;
   a pair of semi-circular stator holes formed to respective ends of both said stators and disposed around said rotor in the form of a circle in a state that both said stators are combined; and
   a coil wound around the periphery of at least one of said stators.

2. An electronically controlled mechanical timepiece according to claim 1 characterized in that coils are wound around the peripheries of both said stators and connected in series to each other.

3. An electronically controlled mechanical timepiece according to claim 1 or 2 characterized in that the coil wound around the periphery of said stator generates electromotive force as well as controls rotation.

4. An electronically controlled mechanical timepiece according to claim 1 characterized in that at least two coils are wound around the peripheries of said stators, at least one of the coils is used to control rotation and at least one of the other coils is used to generate electromotive force to be supplied to the electronic circuit.

5. An electronically controlled mechanical timepiece according to claim 4 characterized in that at least one of the coils used to generate the electromotive force also detects the rotation of said rotor.

6. An electronically controlled mechanical timepiece according to any of claims 1 to 5, characterized by comprising:

   a positioning member capable of being abutted against the edges of both said stators on the stator hole sides thereof; and
   positioning jigs for pressing said stators against said positioning member and abutting them thereagainst.

7. An electronically controlled mechanical timepiece according to claim 6 characterized in that said positioning jigs have inclined surfaces obliquely pressed against the edges of said stators so that said stators are positioned in a height direction by the inclined surfaces.

8. An electronically controlled mechanical timepiece according to any of claims 1 - 7 characterized in that said stators are symmetrically disposed with respect to the right side and the left side.

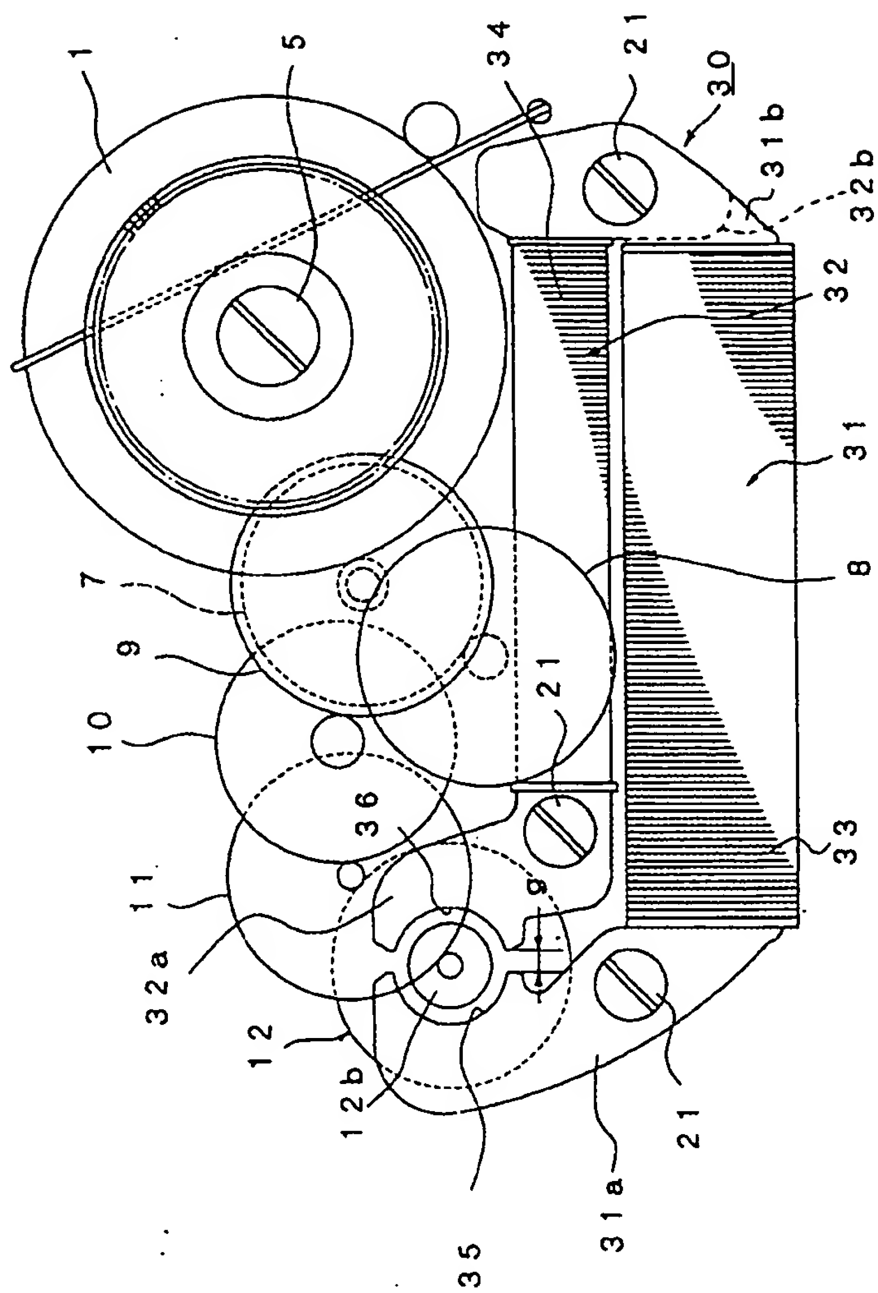
9. An electronically controlled mechanical timepiece according to claim 8 characterized in that the same number of turns of coils are wound around both said stators.

10. An electronically controlled mechanical timepiece according to any of claims 1 - 9 characterized in that an internal notch projecting toward the outside is formed to at least one of confronting positions of the inner peripheries of the stator holes to regulate cogging torque.

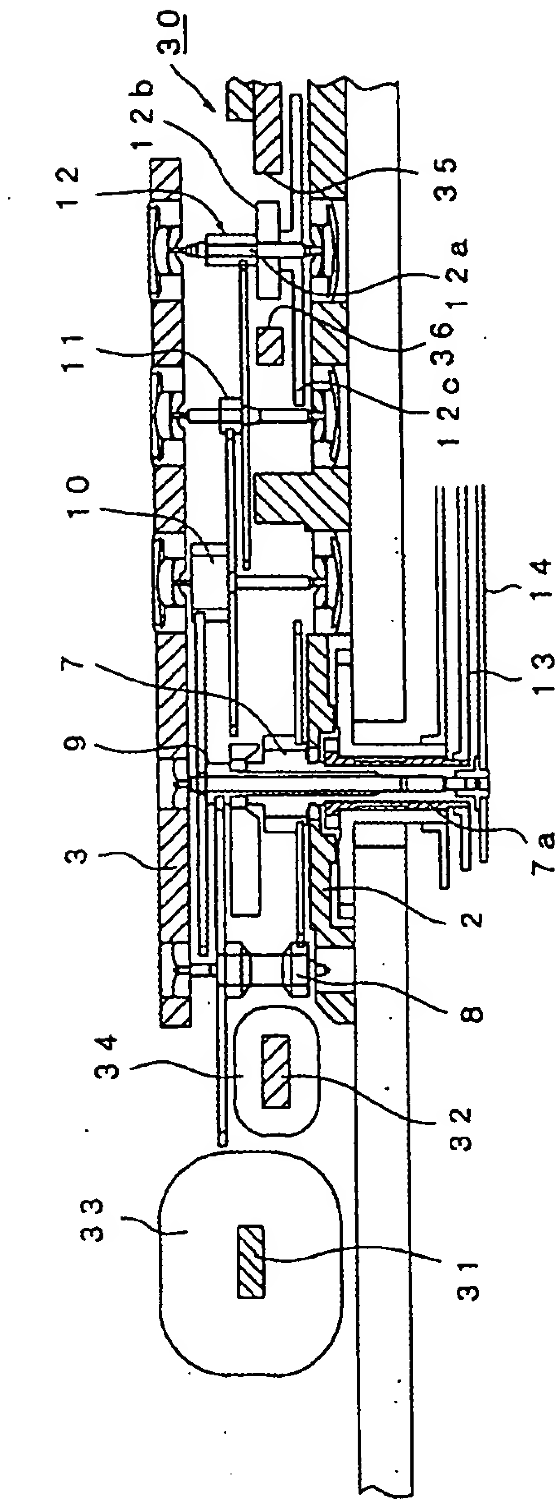
11. An electronically controlled mechanical timepiece according to any of claims 1 - 10 characterized in that the sides of the other ends of said stators which are opposite to the one ends thereof where the stator holes are formed are abutted against each other as well as the lower surfaces of the other ends are abutted against a yoke disposed across said stators.

12. An electronically controlled mechanical timepiece according to any of claims 1 - 11 characterized in that the wheels constituting the train wheel are disposed on a different axial line so that they are disposed at positions where they do not overlap the coil.

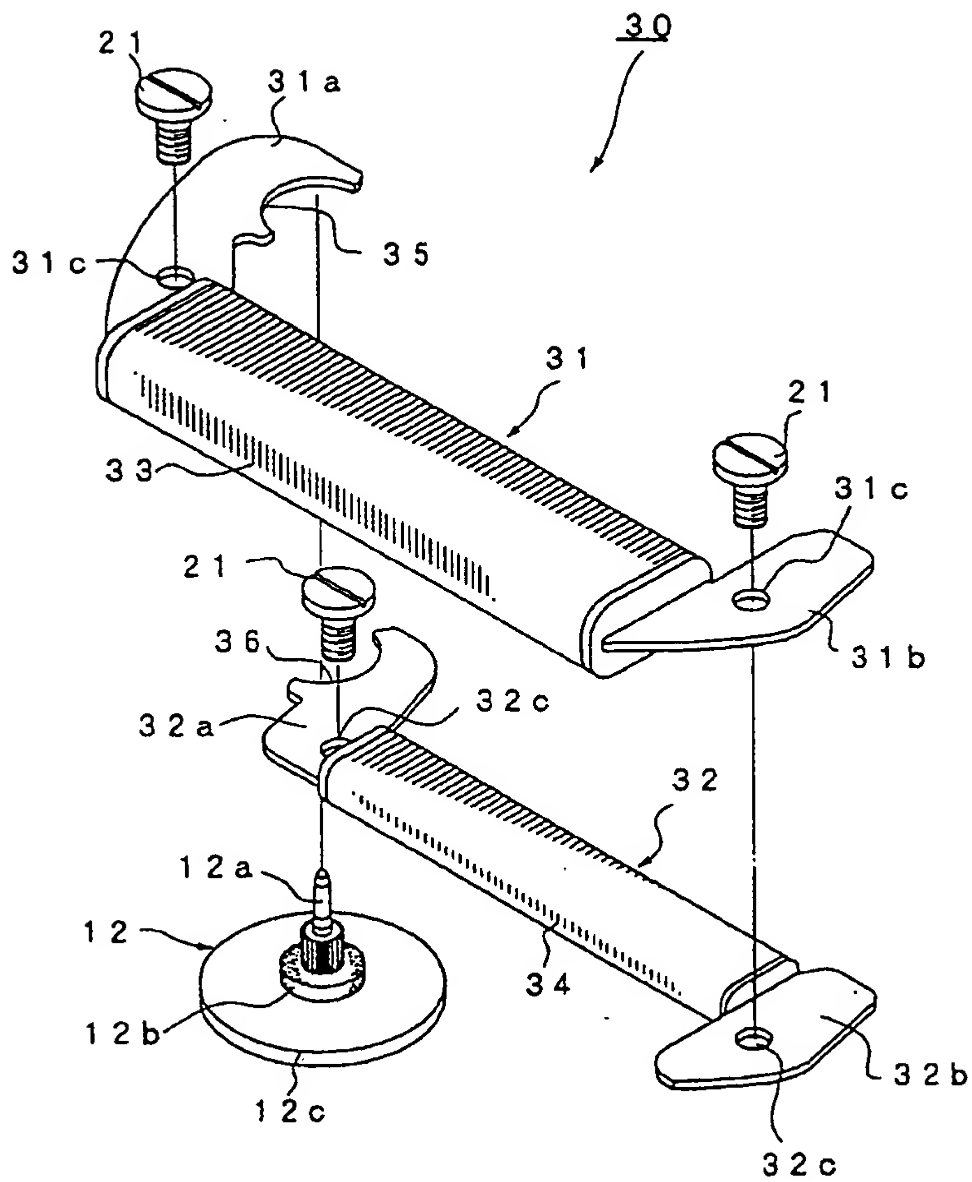
[FIG. 1]



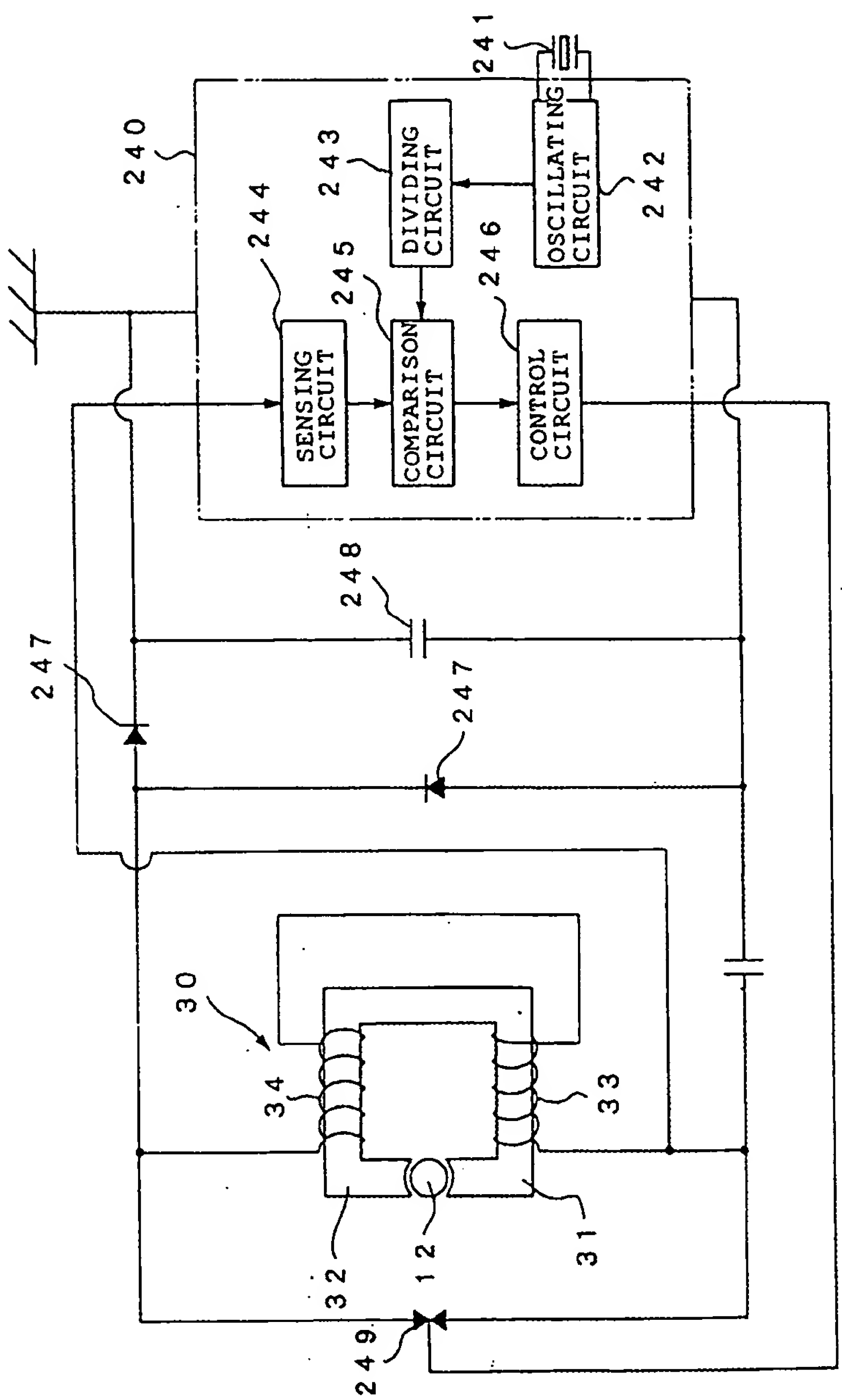
[FIG. 2]



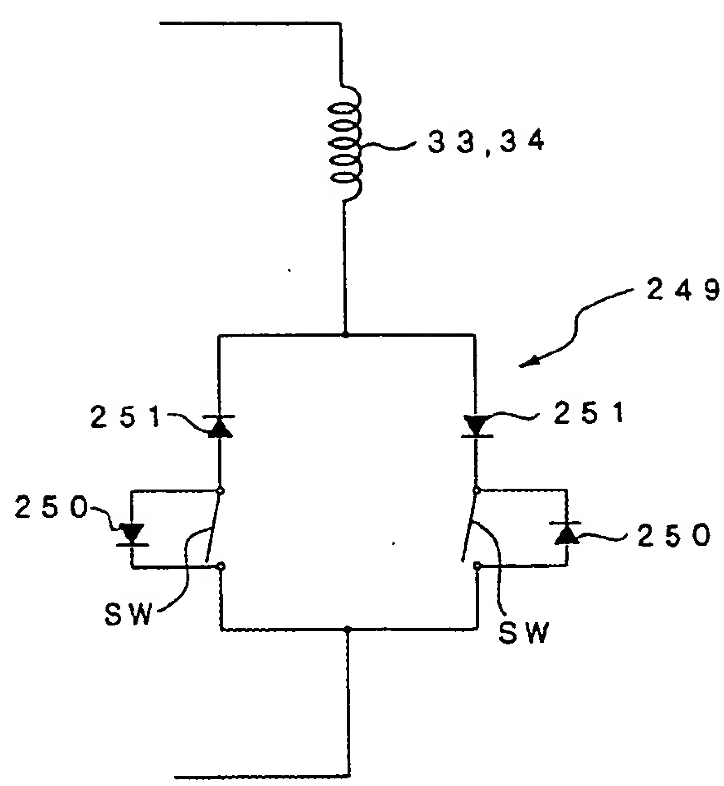
[FIG. 3]


30
21
31a
31c
35
31
33
21
31c
21
36
31b
32c
32a
32
12a
12
34
12b
32b
12c
32c

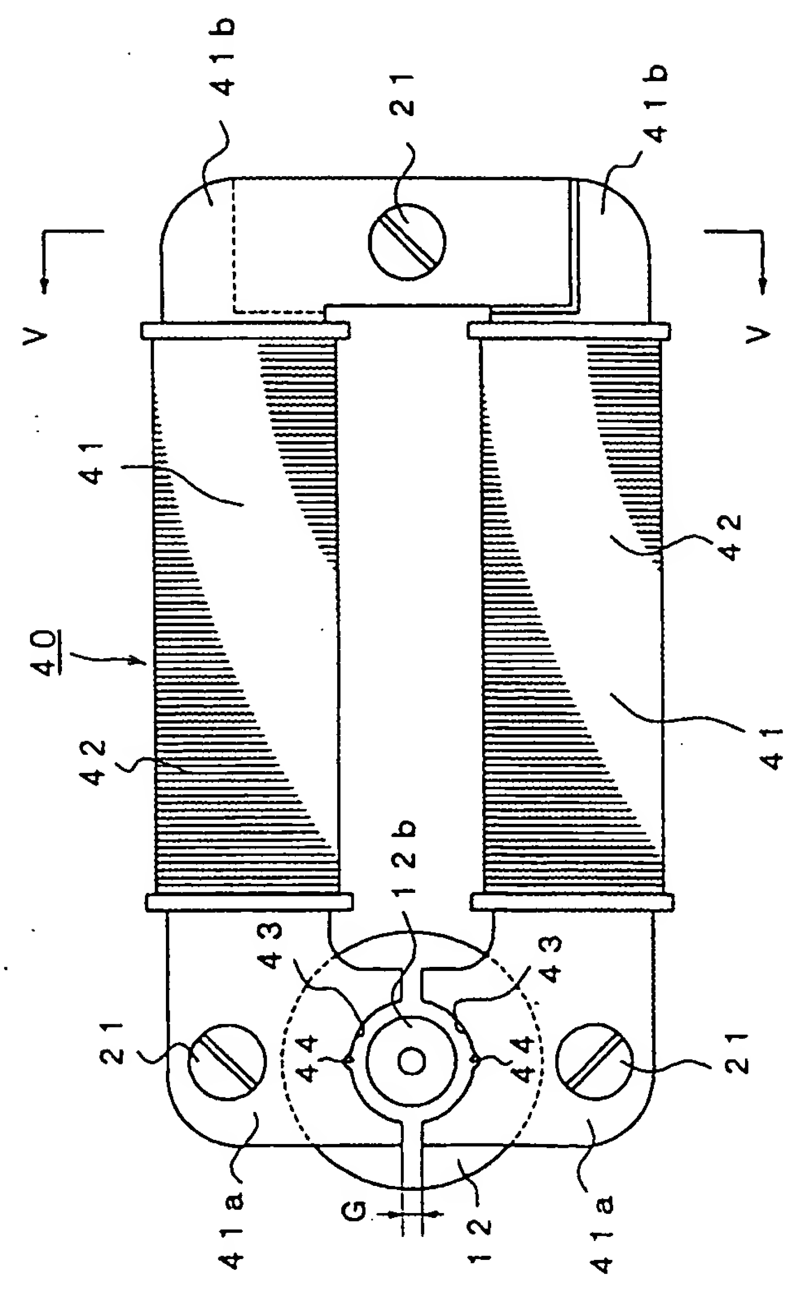
[FIG. 4]


240
241
242
243
244
245
246
247
248
249
SENSING CIRCUIT
COMPARISON CIRCUIT
CONTROL CIRCUIT
DIVIDING CIRCUIT
OSCILLATING CIRCUIT
30
31
32
33
34
12

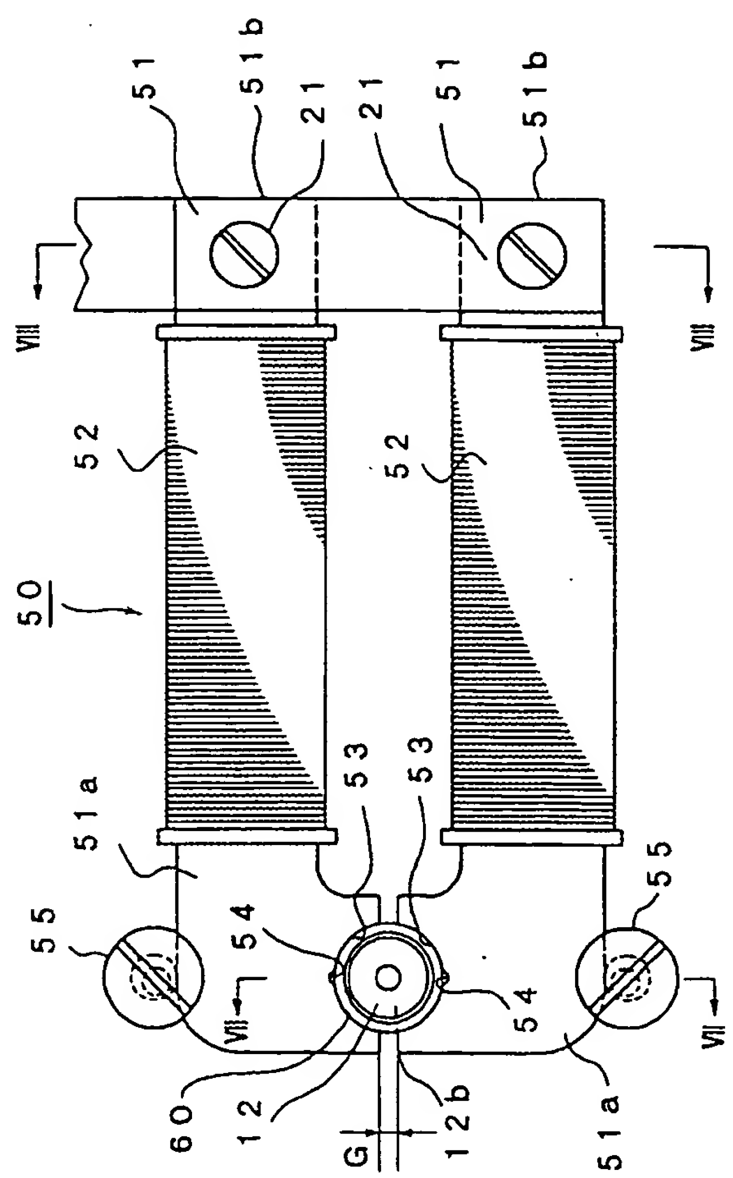
[FIG. 5]



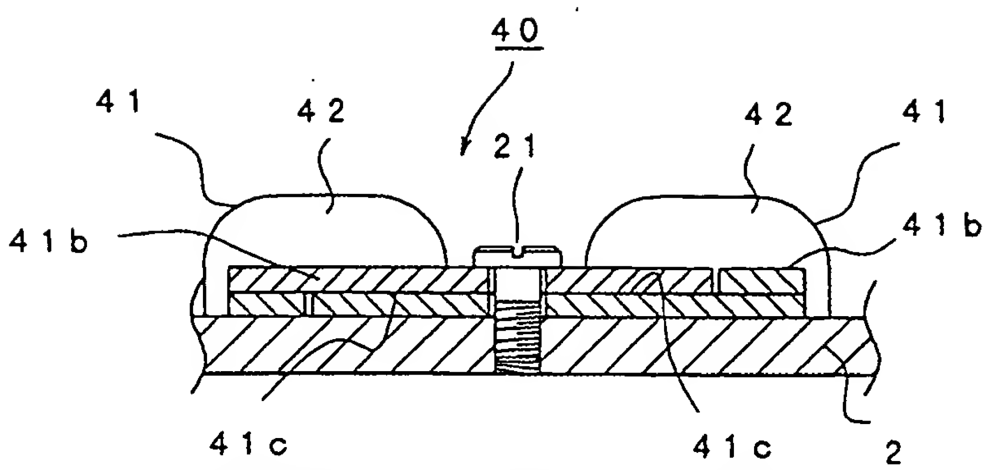
[FIG. 6]



[FIG. 8]

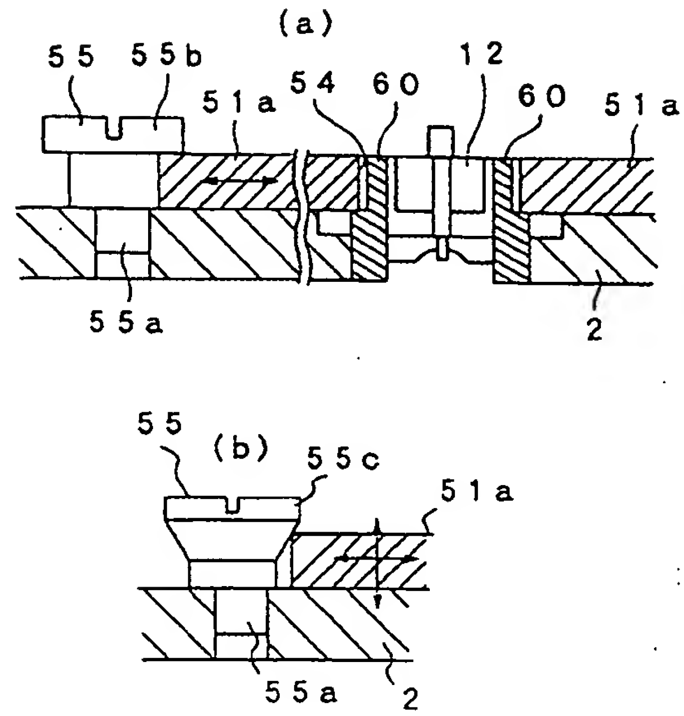

51
51b
21
21
51
51b
VIII
VIII
52
52
50
51a
53
53
55
55
54
54
VII
VII
60
12
G
12b
51a

[FIG. 7]

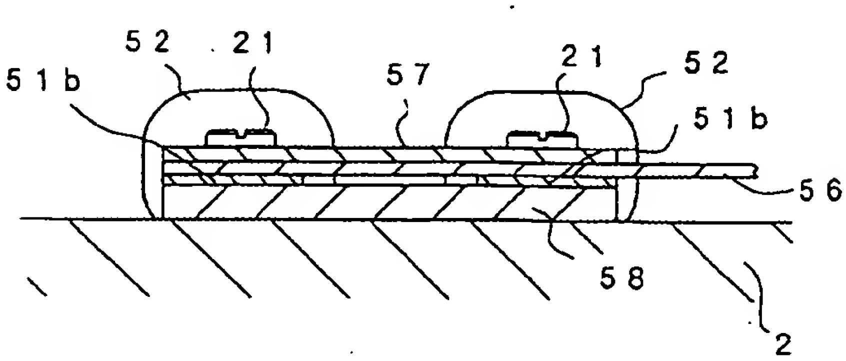


SECTIONAL VIEW TAKEN ALONG LINE V - V

[FIG.9]

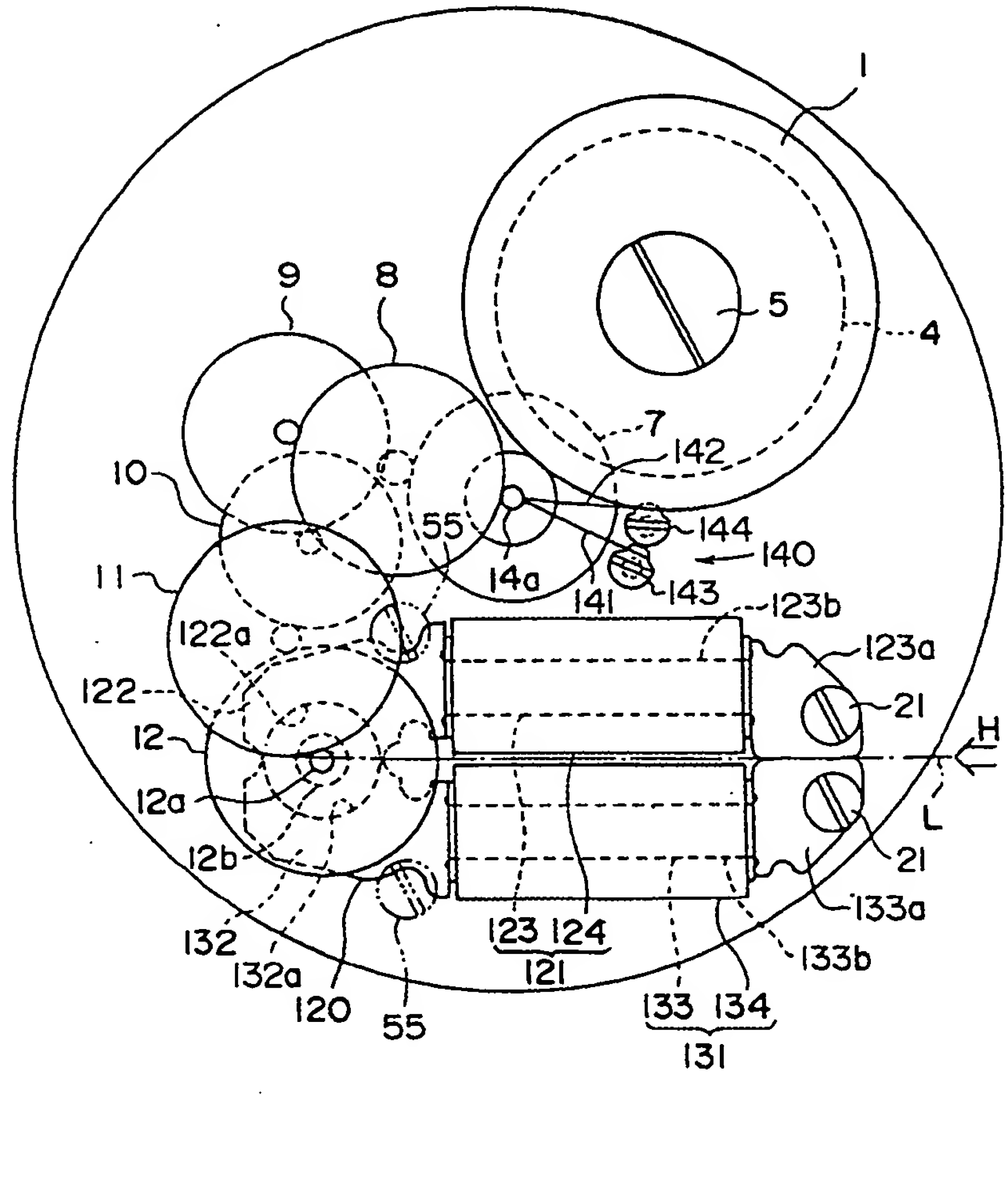


[FIG. 10]

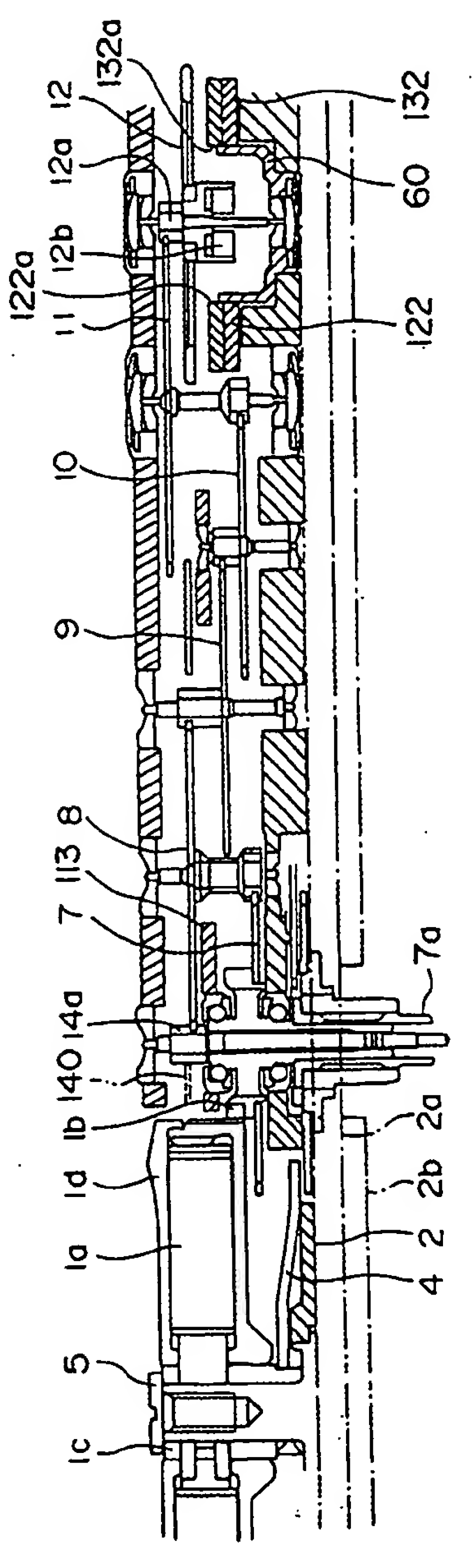


SECTIONAL VIEW TAKEN ALONG LINE VIII - VIII

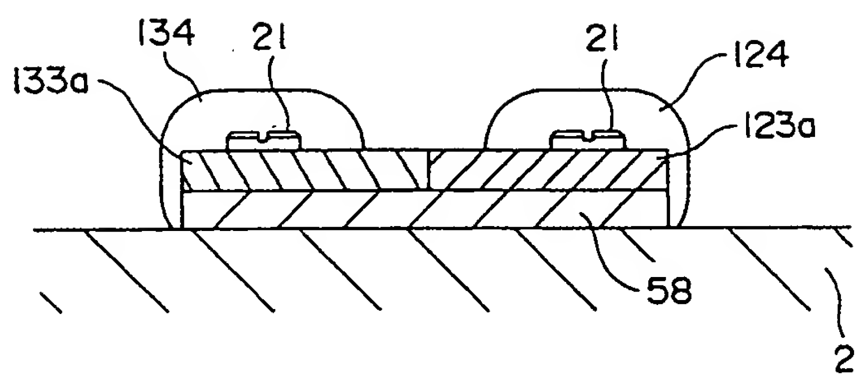
[FIG. 11]


1
9
8
5
4
7
142
10
144
140
55
14a
143
11
141
123b
122a
123a
122
21
12
H
12a
L
21
12b
133a
132
123 124
133b
132a
121
120
133 134
55
131

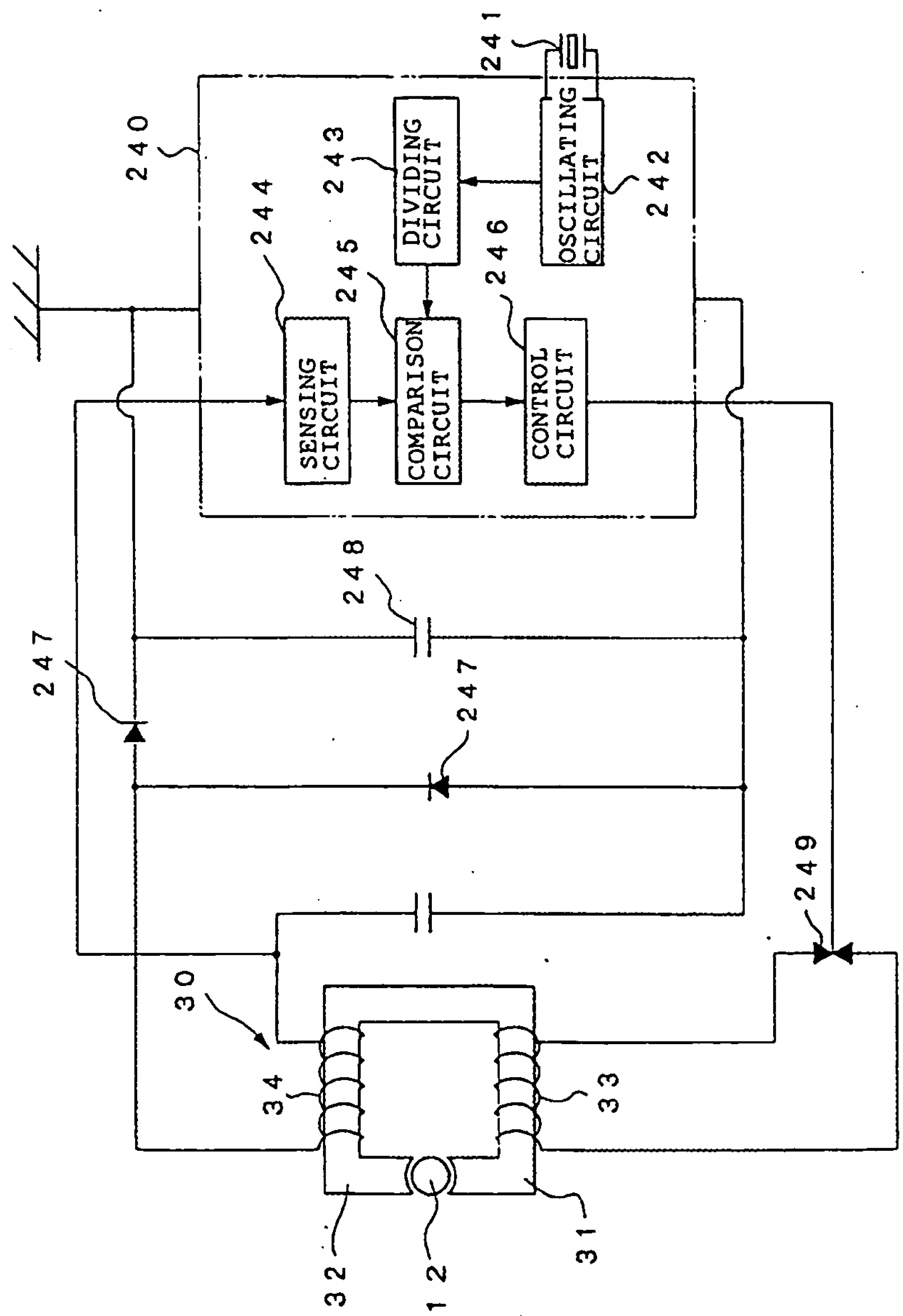
[FIG. 12]


132a
12
12a
12b
122a
11
10
9
8
113
7
14a
140
1b
1d
1a
5
1c
132
60
122
7a
2a
2b
2
4

[FIG. 13]



[FIG. 14]



240
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249
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31
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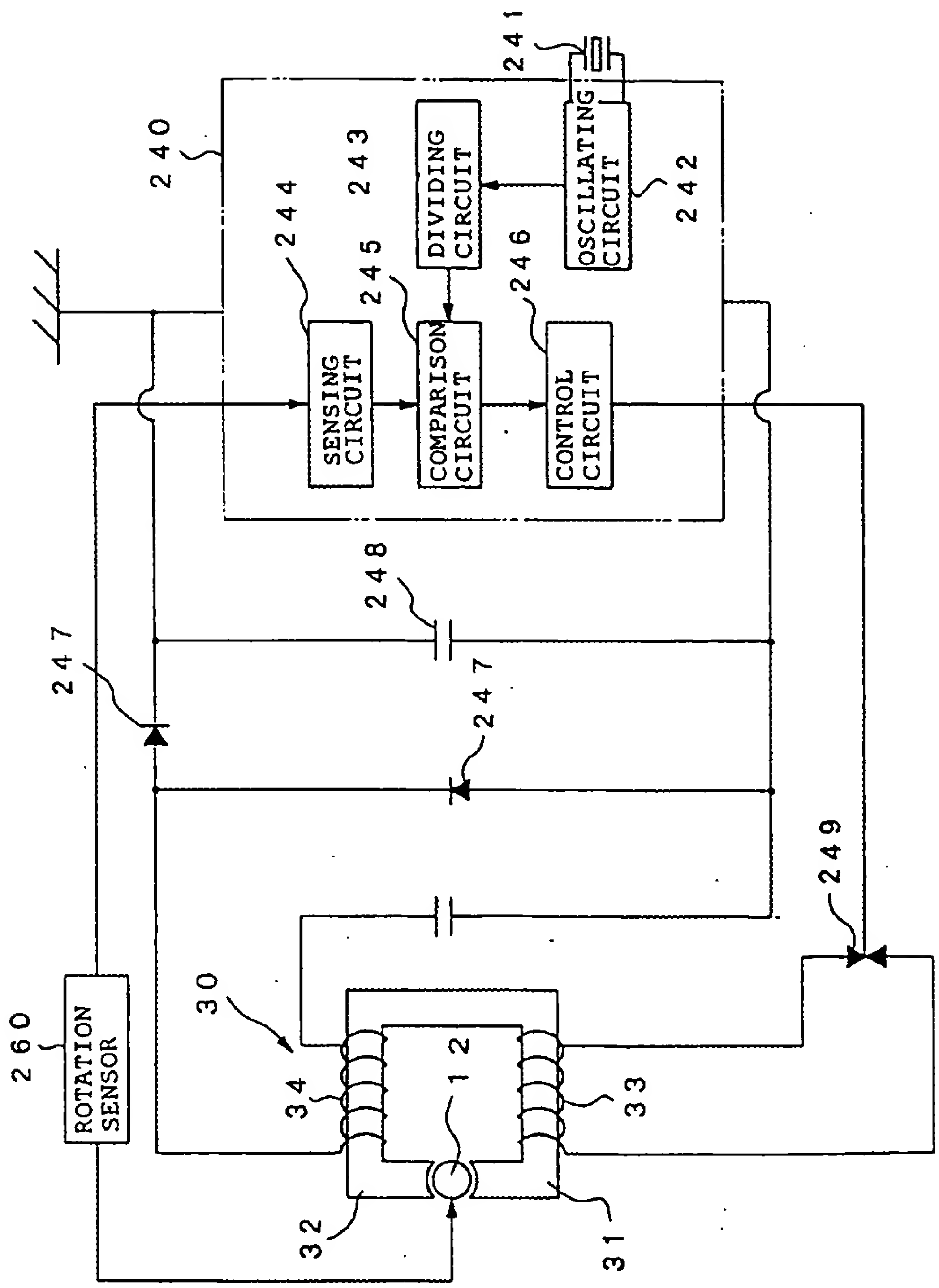
12
SENSING CIRCUIT
COMPARISON CIRCUIT
CONTROL CIRCUIT
DIVIDING CIRCUIT
OSCILLATING CIRCUIT

[FIG. 15]


240
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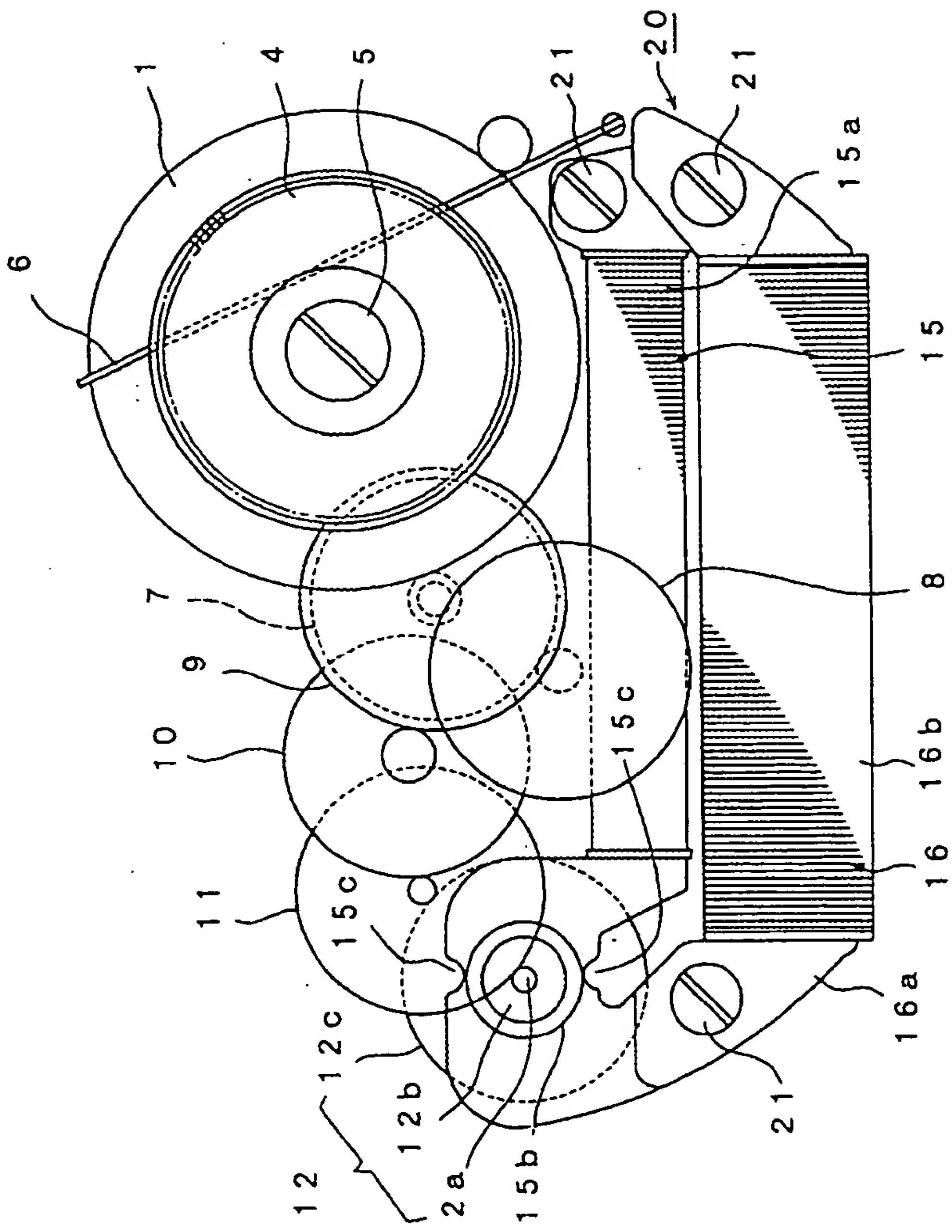
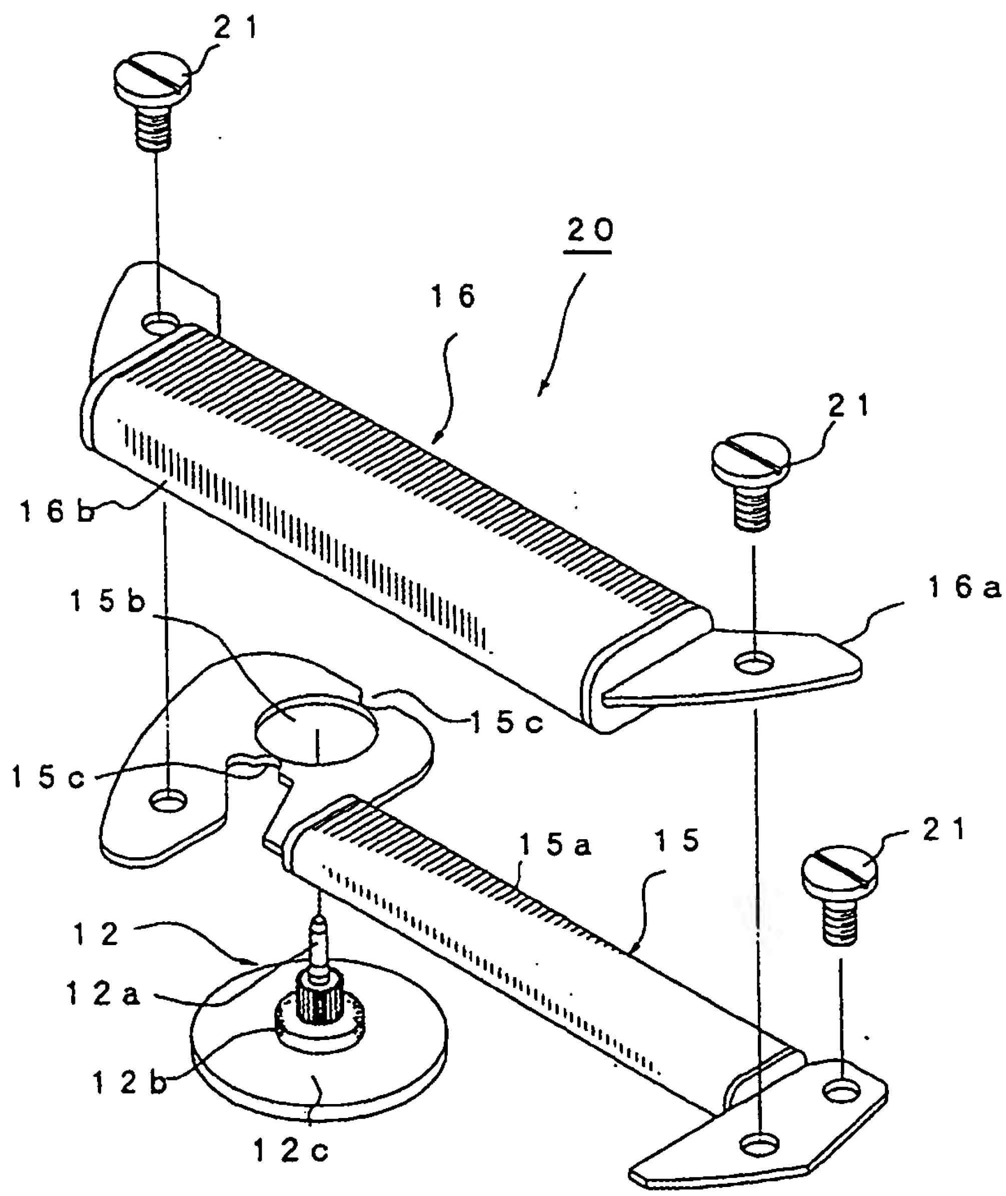
244
245
246
247
248
249
260
30
31
32
33
34
12
SENSING CIRCUIT
COMPARISON CIRCUIT
CONTROL CIRCUIT
DIVIDING CIRCUIT
OSCILLATING CIRCUIT
ROTATION SENSOR

[FIG. 16]

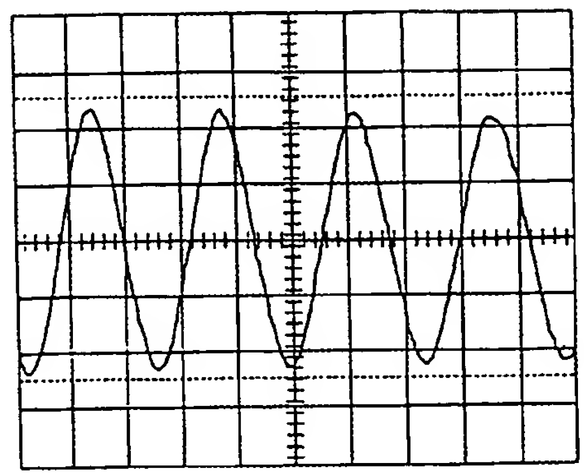

1
4
5
6
20
21
21
15a
15
8
16b
16
16a
21
7
9
10
11
15c
15c
12c
12b
12a
15b
12

[FIG. 17]



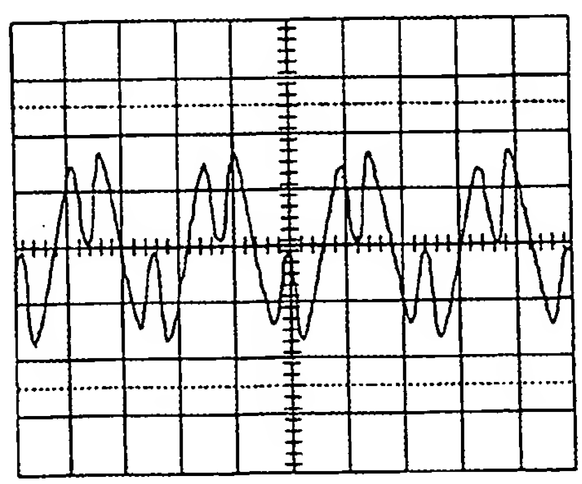
[FIG. 18]

(a)



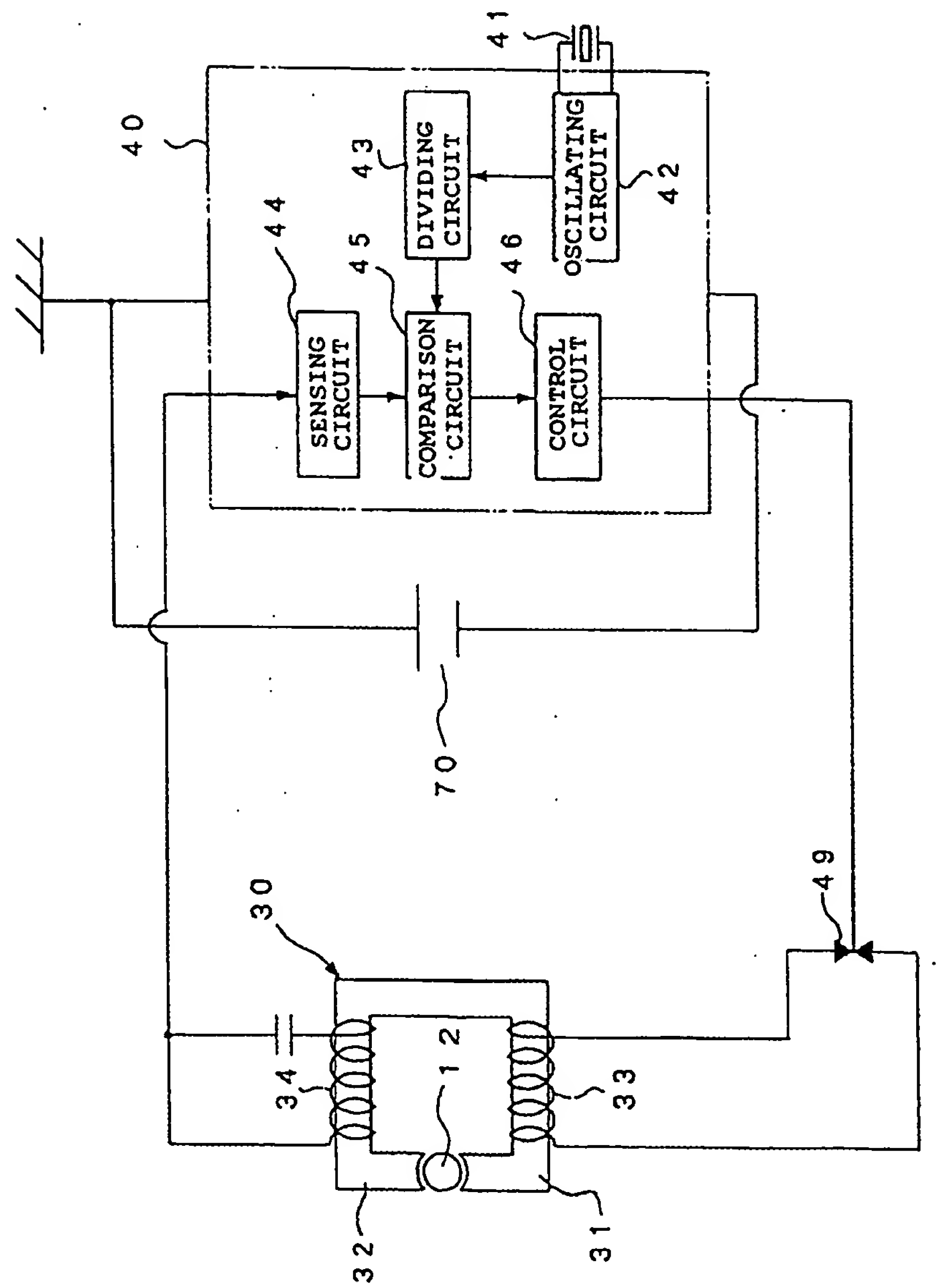
(Waveform of power generated by the present invention)

(b)



(Waveform of conventional generated power)

[FIG. 19]


41
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DIVIDING CIRCUIT
43
OSCILLATING CIRCUIT
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44
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46
SENSING CIRCUIT
COMPARISON CIRCUIT
CONTROL CIRCUIT
70
30
49
12
34
33
32
31

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 30 7793

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 239 820 A (ASULAB SA) 7 October 1987 * figures 1,5,7 * ---	1-5,8-12	G04C10/00
A	FR 2 464 516 A (LAVET MARIUS) 6 March 1981 * figures 1-3 * ---	1-5,8-12	
A	EP 0 679 969 A (SEIKO EPSON CORP) 2 November 1995 * figures 1-22 * ---	1-12	
A	PATENT ABSTRACTS OF JAPAN vol. 004, no. 032 (E-002), 19 March 1980 & JP 55 005089 A (RICOH ELEMEX CORP), 14 January 1980 * abstract * ---	6,7	
A	US 3 432 735 A (PETRIDES CHRISTIE) 11 March 1969 * figure 1 * ---	1	
P,A	WO 98 27473 A (PATEK PHILIPPE SA ;SCHWAB MICHEL (CH); TU MAI XUAN (CH); MUSY JEAN) 25 June 1998 * figures 1-8 * -----	1-12	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 December 1998	Exelmans, U

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 30 7793

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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